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Editorial Comment

Wait for Weight or "Waste" the Waist

The Benefits of Early Intervention in Childhood Obesity*

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In developed nations, the sharpest rise in the prevalence of obesity over the last 3 decades has been in children and young adults (1). The reasons why this is particularly worrisome are that childhood obesity is strongly associated with the development of major risk factors for atherosclerosis in early life (such as hyperlipidemia, hypertension, and diabetes) (2) and that there is a strong persistence of obesity from childhood to adulthood (3). Furthermore, childhood obesity is already associated with maladaptive changes in the arterial vasculature, including dysfunction of the arterial endothelium and thickened carotid artery walls (4). The prevalence of childhood obesity still continues to increase, even in developing countries (5), despite enormous publicity and public awareness about the nature and scale of the problem.

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There are a variety of social and cultural determinants of this epidemic of childhood obesity, including the low cost of high-fat and high-sugar meals—which are often conveniently quick for busy working families and are often marketed to appeal to children—as well as declines in total energy expended (with increasing sedentary time).

What can be done to protect the heart and blood vessels of overweight and obese children? In 2004, Woo et al. (6) from Hong Kong in collaboration with our group documented that a combination of diet and exercise could improve arterial endothelial function and reduce carotid artery wall thickness in mildly to moderately overweight 11-year-old children, but that such improvement likely required continuing exercise. This study used surrogate end points for vascular health but at least suggested that benefits could accrue and indeed be sustained, even without changing total body weight and with only a relatively modest reduction in total body fat (replaced by muscle).

In this issue of the *Journal*, Farpour-Lambert et al. (7) provide novel information extending our knowledge about potential cardiovascular benefits in obese children. In a controlled clinical trial, pre-pubertal children ages 6 to 11 years with body mass index (BMI) over the 97th age- and sex-specific percentile were randomized to 3 months' exercise training after school or usual exercise patterns, with a further 3-month follow-up period where both groups of children were encouraged to exercise regularly. The structured exercise sessions were supervised and deliberately made enjoyable for the children, with activities including swimming and ball games. Each 60-min session comprised 30 min of aerobic work with target energy expenditure individualized at 55% to 65% measured maximum exercise capacity for each child, followed by 20 min of strength work and 10 min of stretching. The children attended over 80% of the scheduled sessions, and the benefits were significant and striking. At baseline, the obese children had higher blood pressure, abdominal fat, insulin resistance indexes, and arterial stiffness compared with lean control subjects, and at 3 months there was an average fall in 24-h systolic blood pressure of 7 mm Hg in the exercise group as well as improvements in abdominal fatness and aerobic capacity. At 6 months, there were further significant benefits in terms of arterial stiffness and carotid artery wall thickness, in the children initially randomized to exercise. Therefore, this important study showed that achievable physical activity could reduce blood pressure, arterial stiffness, and abdominal fat in obese children.

One of the key observations of this study was that BMI did not change in the exercise group, because the approximately 2% loss of whole body fat over 3 months (particularly loss of abdominal fat) was offset by a 1.2-kg gain of fat-free mass. Thus, clinical exercise programs in children should monitor percent body fat rather than BMI, to measure effectiveness of the physical activity program prescribed. Waist circumference, for example, is a simple parameter to monitor, although dual energy X-ray absorptiometry scans provide better direct measure of obesity and location.

There were some limitations to the study. A food record was attempted but incomplete in over one-half of the children. In those who did complete the 3-day food record accurately, the exercise group ingested significantly fewer calories/day than the control group (350 fewer Kcal/day vs. no change), suggesting that dietary changes also occurred in the exercise group as well as attending the exercise sessions (even though dietary instruction was not given).

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Furthermore, the mechanism of benefit was not specifically assessed in this study; the authors speculate that exercise-based upregulation of vascular nitric oxide production, changes in autonomic nervous system function, and/or changes in insulin sensitivity might play a role. Nevertheless, a message of benefit from this short-term exercise-based intervention is clear and informative.

Understanding the mechanism of benefits from exercise in obesity is of practical as well as academic interest. Recent data from Ristow et al. (8), for example, have shown that the exercise-induced benefits on insulin sensitivity are almost completely abrogated by antioxidant supplementation. Exercise-induced oxidative stress occurred via mitochondrial formation of reactive oxygen species, which led to an adaptive response promoting endogenous antioxidant defense capacity and amelioration of insulin resistance. This surprising finding underscores the importance of elucidating the mechanism(s) of exercise-related benefits on cardiovascular health, to inform lifestyle and potential pharmacologic cointerventions with exercise that could conceivably attenuate or enhance benefit.

Much work remains to optimize recommendations for exercise activities in children, both healthy and overweight/obese. The clinical research community needs to define the type, frequency, intensity, and duration of exercise to maximize both adherence and benefit. We have to understand which age groups benefit the most from intervention and which disease populations require which type of diet and exercise intervention. Finally, we need to understand how to facilitate participation in exercise programs. In this regard, investigators are studying school-based programs (9), and early information suggests that beneficial exercise programs for adults can be introduced successfully into the workplace (10). Socioeconomic considerations are important here also; exercise requires time and opportunity (access to parks, walking or cycling tracks, and/or gym facilities). For children, exercise needs to be enjoyable and appealing (because the effort needs to be sustained) (6), especially in an environment where entertaining sedentary opportunities abound (television, Internet, and so forth).

Data are beginning to emerge to answer some of these questions. Any type of exercise is better than no exercise at all. Vona et al. (11) have shown that aerobic or resistance or combination training all improve coronary endothelial function to a similar degree in patients with coronary artery disease, but the benefit depends on continuing the training. Exercise-related benefit correlates with the amount of muscle mass trained (12). The degree of exercise must be sufficient to increase arterial shear stress enough to enhance systemic nitric oxide release (13); such observations will help inform questions of frequency, intensity, and duration of training required.

Whereas the current study indicates that exercise has benefits in terms of lowering blood pressure in obese young children (7), exercise does not seem to reduce resting blood pressure in nonobese children (14). Furthermore, prepubertal children might gain less benefit from participation in an exercise program compared with adolescents and young adults (15). Thus, although it is practically and intuitively clear that exercise is good for the cardiovasculature, we obviously have much to learn about guidelines and implementation.

Many commentators have called for urgent action to prevent childhood and adolescent obesity and its health consequences. The work of Farpour-Lambert et al. (7) has given us important motivation to progress along this challenging trail.

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